CERN/DG/Research Board 2008-386
Minutes-185
7 October 2008

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE

CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN RESEARCH BOARD

MINUTES OF THE 185th MEETING OF THE RESEARCH BOARD
HELD ON WEDNESDAY 3 SEPTEMBER 2008

Present R. Aymar (Chairman), J.J. Blaising, J. Dainton, J. Engelen, L. Evans, M. Ferro-Luzzi, R. Forty (Secretary), G. Giudice (replacing L. Alvarez-Gaume), E. Heijne, A. Herlert, P. Lebrun, S. Myers, E. Perez, W. von Rüden, V. Vuillemin, T. Wyatt

Invited R. Heuer

Apologies L. Alvarez-Gaume, M. Huyse

Items

1. Procedure
2. Report from the LHCC meeting of 2-3 July 2008
3. Report from the SPSC meeting of 15-16 July 2008
4. Any other business

1. PROCEDURE

1.1 R. Aymar welcomed R. Heuer, who attended the meeting as Director General elect. The **minutes** of the Research Board meeting held on 28 May 2008 [1] were approved without modification. There were three **matters arising** from the minutes, listed in the following paragraphs.

1.2 In Item 1.3 it was stated that a report from AB department was requested for this Research Board, specifying the resources required for consolidation of the **AD** under two scenarios: end of operation in 2012, or in 2016. A report was tabled at the meeting, and is attached [2]; S. Myers presented its main conclusions [3]. R. Aymar stated that the AD remains an important part of the basic programme of CERN, and that there is clear intention from the CERN management to prolong the operation of the facility if feasible; however as resources are scarce, those required for consolidation of the AD must be scrutinized. As the report had only just been received, no decision will be taken until the next Research Board meeting, after a detailed review of the risk analysis and costs. A decision on approval of the proposed experiment AEGIS is also postponed until the prolongation of the AD has been decided, but the collaboration is encouraged to explore funding opportunities.

1.3 In Item 1.4, concerning the Giga-Tracker R&D for **P326**, it was stated that the level of support required from CERN must be defined in discussion with the CERN directorate before a decision could be taken. J. Engelen reported that this discussion had indeed taken place and had concluded positively, with resources from CERN approved for the R&D foreseen in 2008 and 2009.

1.4 In Item 2.2 it was stated that the Research Board granted Recognized Experiment status to **MAGIC**, on condition that a Memorandum of Understanding was established between the collaboration and CERN, specifying the use that may be made of CERN resources. J.J. Blaising reported that in discussion with the proponents it had been clarified that the requested CERN support was not available in PH department, and as a result the proponents had withdrawn their request. A MoU was therefore no longer required.

2. REPORT FROM THE LHCC MEETING OF 2-3 JULY 2008

2.1 T. Wyatt presented the report from the latest meeting of the LHCC, including mini-reviews of the LCG and the upgrade plans of ATLAS and CMS, as well as progress reports from the LHC experiments as final preparations are made for first beam [3]. L. Evans commented that this was an exciting time for the LHC project, as first circulating beam was scheduled for 10 September. **The Research Board took note.**

2.2 Concerning the upgrade plans of the LHC experiments, R. Aymar stated that he welcomed input from the LHCC within its role as provider of peer review of proposals from or follow-up of outside bodies, and thus as an advisory body to the CERN management, in particular for feedback on related developments within the experiments. However, the decision on the schedule of any LHC upgrade would remain the responsibility of the CERN management.

2.3 E. Heijne pointed out that after prolonged running of the LHC it will be more difficult to carry out the operations for the upgrading and subsequent maintenance, due to the radiation from activation. He suggested that the LHCC should include the design aspects needed to make the future equipment less sensitive to activation and easier to handle with remote manipulation, in their evaluation of the future technical proposals for the upgrades. J.J. Blaising commented that, in accordance with the CERN Safety Commission, strict procedures were already in place for organizing such interventions, and for dealing with any irradiated material.

2.4 The ATLAS Technical Design Report on the Forward Detectors for the Measurement of Elastic Scattering and Luminosity [4] describes a set of detectors to be located in the very forward region. The detectors will be housed in Roman Pots and measure elastic scattering at small angles to determine the absolute luminosity. The TDR had been reviewed by the LHCC [5] and was **approved by the Research Board.**

3. REPORT FROM THE SPSC MEETING OF 15-16 JULY 2008

3.1 J. Dainton presented the report from the latest meeting of the SPSC, including the annual reviews of COMPASS, OPERA, and ICARUS [3]. He commented that clear benefits had been seen from the refurbishment of the accelerators, and passed on the appreciation of the committee for that effort. **The Research Board took note.**

3.2 The **CRYSTAL** experiment proposes to assess the possibility of using bent silicon crystals as a primary collimator [6]. The SPSC recognized that the proposal addresses important R&D that may be of relevance to a future upgrade of the LHC. **The experiment was approved by the Research Board, subject to the availability of resources, and will have reference number UA9.**

4. ANY OTHER BUSINESS

4.1 The Research Board **dates for 2009** were approved: 4 March, 3 June, 2 September, and 2 December (Wednesday mornings starting at 9:00).

4.2 E. Perez presented the case for an extension of the **AD** run this year [3]. The start-up had been delayed by the need to replace a magnet, and there had been lower efficiency than usual in the early part of the run. **The Research Board agreed that, if the PS continues to run beyond 15 November for other reasons, the AD run could exceptionally be extended for that period.**

4.3 The **next meeting** of the Research Board will be held at 9:00 on 5 December 2008. Note that is a change of date compared to that previously foreseen.

ENCLOSURES

1. Minutes of the 94th LHCC meeting (LHCC-2008-010 LHCC-94).
2. Report on AD Consolidation for operation beyond 2010.

REFERENCES

[1] Minutes of the 184th meeting of the Research Board (CERN/DG/RB 2008-383).

[2] Report on AD Consolidation for operation beyond 2010 (attached).

[3] Copies of the transparencies are attached to the agenda: http://indico.cern.ch/conferenceDisplay.py?confId=39457

[4] Technical Design Report: ATLAS Forward Detectors for Measurement of Elastic Scattering and Luminosity (LHCC-2008-004/ATLAS TDR 18).

[5] Review of the ATLAS Technical Design Report on the Forward Detectors for the Measurement of Elastic Scattering and Luminosity (LHCC-2008-013/G-140).

[6] Proposal of the Crystal Experiment (SPSC-2008-014/P-335).

CERN/LHCC 2008-010

LHCC 94
3 July 2008

LARGE HADRON COLLIDER COMMITTEE

Minutes of the ninety-fourth meeting held on
Wednesday and Thursday, 2-3 July 2008

OPEN SESSION

1. LHC Hardware Commissioning Status Report: Roberto Saban
2. LHCb Status Report: Andrei Golutvin
3. Proposal for R&D on the Development of Micro-Pattern Gas Detector: Leszek Ropelewski

CLOSED SESSION:

Present: J.-J. Blaising, S. Dalla Torre, S. de Jong, J. Engelen, M. Ferro-Luzzi, F. Forti, M. Gonin, C. Hawkes, V. Kekelidze, J. Knobloch, W. Kuehn, M. Mangano, R. Mankel, M. Martinez-Perez, P. Mato, C. Niebuhr, A. Nomerotski, E. Perez, B. Peyaud, S. Smith, E. Tsesmelis (Secretary), T. Wyatt (Chairman), R. Yoshida

*part-time

Apologies: J. Haba

1. PROCEDURE

The Chairman welcomed the new members, Chris Hawkes, Wolfgang Kuehn and Andrei Nomerotski, to the Committee.
The minutes of the ninety-third LHCC meeting (LHCC 2008-008 / LHCC 93) were approved.

2. REPORT FROM THE CHIEF SCIENTIFIC OFFICER

The Chief Scientific Officer (CSO) reported on issues related to the LHC. He reported good progress in the cool-down and hardware commissioning of the LHC machine. All sectors have been cooled down and hardware commissioning is advancing in parallel in several sectors. In light of the current status, the exact date on which the LHC machine and experimental areas will be closed is presently under review. Commissioning of the LHC experiments is well underway, and includes extended global cosmic-ray runs. Discussions for the LHC luminosity upgrade, regarding both the accelerator and the experiments, have started with a view of approaching funding agencies for new investments in this area.

3. REPORT FROM THE ALICE REFEREES

The LHCC heard a report from the ALICE referees, concentrating on the status of the installation and commissioning of the experiment.

Very good progress was reported on the ALICE detector installation. All the detector elements delivered to Point 2 have been installed and the solenoid magnet doors have been closed. Installation of the final elements of the radiation shielding is well underway. The current planning has ALICE ready for beam on 28 July 2008 and will include the full hadron and muon capabilities of the experiment, while the full electron and photon detection will be finalized later.

The referees also reported on the status of the ALICE commissioning. Global commissioning of the ALICE experiment is in progress. Thousands of tracks in the Inner Tracking System (ITS) and Time Projection Chamber (TPC) have been recorded and the first results on the detector alignment have been obtained. In parallel, commissioning of the ALICE DAQ is well underway with the global cosmic-ray runs and also with dedicated runs of the ITS, TPC and V0 detectors. Commissioning of the ITS cooling systems has been finalized, but only after lengthy delays due to problems with the working points. Good progress was reported on the TPC, but difficulties were experienced with the stable operation of the cooling of the front-end electronics and a number of front-end cards are not functioning. The commissioning of the Muon Tracking Stations 3/4/5 has been delayed, due primarily to the noise problems in the Wiener power supplies. The power supplies are currently being repaired. The Time-of-Flight (TOF) detector is providing a very useful cosmic-ray trigger by using coincidences between several modules. The problem associated with the DC-DC converters that appear not to function in the magnetic field is under investigation.

4. REPORT FROM THE ATLAS REFEREES

The LHCC heard a report from the ATLAS referees, concentrating on the status of the experiment and the Full Dress Rehearsal.

The referees reported on the status of the experiment. The ATLAS detectors are in their final positions and the Inner Detector (ID), Calorimeters and Small Wheel muon chambers have been closed around the experimental beam pipe. Both the Solenoid and Barrel Toroid magnet systems have been tested and are operational. The leak in the helium line of the End-cap Toroid (ECT-A) has been repaired and is now undergoing final tests. A global test of all ATLAS magnets is scheduled to be completed by mid-August 2008. Repair of the ID evaporative cooling plant has made impressive progress. All problems have been resolved and the plant is expected to be fully operational in July 2008, in time for the bake-out of the experimental beam pipe by the end of July 2008. Commissioning of the Semiconductor Tracker (SCT) and Pixel Detector has been put on hold, awaiting the completion of the repair to the cooling plant. Having the ID operational for the LHC start-up requires the optimization of procedures and software tools in order to speed up the detector's commissioning. Commissioning of the Transition Radiation Tracker (TRT) is progressing well. The critical issue remains the timely availability of the TRT read-out drivers. The LHCC noted the reduction in performance of the LAr End-cap Calorimeter low voltage power supplies in the magnetic field. A dedicated ATLAS team is investigating the issue and the set up for the first LHC run.

The LHCC also heard a report on the ATLAS Full Dress Rehearsal. The exercise proved to be a very useful step in getting the ATLAS computing ready for LHC operation. The

basic ATLAS computing is functioning and many problems were addressed successfully during the exercise. Additional effort on the calibration loop and express stream, together with an enhanced co-ordination of activities at the Tier-1 and Tier-2 centres, is still required.

5. ATLAS TECHNICAL DESIGN REPORT ON THE FORWARD DETECTORS FOR THE MEASUREMENT OF ELASTIC SCATTERING AND LUMINOSITY

The LHCC has completed its scientific and technical evaluation of the ATLAS Technical Design Report (TDR) on the Forward Detectors for the Measurement of Elastic Scattering and Luminosity (LHCC 2008-004 / ATLAS TDR 18) submitted in January 2008. The Committee was impressed by the quality of the work presented in the TDR and congratulates the Collaboration. The concept of the ATLAS Forward Detectors, built around the Roman Pot stations of the ALFA (Absolute Luminosity For ATLAS) detector, is well-suited to the challenge of providing a measurement of the elastic scattering and luminosity. The TDR demonstrates that the technological issues do not pose potentially prohibitive problems.

The Committee has no major concerns. An ancillary document (LHCC 2008-011) records the overall assessment by the LHCC of the project at this time, thereby emphasizing some points which should be monitored in the future as the project progresses. The LHCC review of the TDR was not a detailed review of the engineering or procurement readiness.

Recommendation:

The LHCC recommends general approval of the ATLAS Technical Design Report on the Forward Detectors for the Measurement of Elastic Scattering and Luminosity. The LHCC considers the schedule given in the TDR to be appropriate. The schedule will be used by the Committee to measure and regulate the future progress of the project.

6. REPORT ON THE CMS REFEREES

The LHCC heard a report from the CMS referees, concentrating on the installation and commissioning of the experiment, the computing and the preparations for sustained operation.

The referees reported on the installation of the CMS experiment. The experimental beam pipe is leak-tight and baked-out and the trial insertion and closure of the Pixel Detector was successful. A one-month delay was reported in some parts of the Tracker commissioning due to a serious failure in the condenser/heat exchanger. The condenser, evaporator and all heat exchangers have been changed and the final check-out is in progress following the re-start of the cooling plant. Construction of the four Dee modules making up the End-cap Electromagnetic (EE) Calorimeter is advancing well. Dee-1 is complete, Dee-2 is undergoing final tests and commissioning, commissioning of Dee-3 has started and Dee-4 construction is approaching completion. Good progress was also reported on the Beam Radiation Monitors, with all systems expected to be ready for installation on schedule. Problems in the integration of the Preshower Detector have caused delays in the mounting of the ladders and the installation of the detector in CMS

will only be possible during the first LHC shut-down. Failures of the magnetic field rack ventilation units are continuing at an average rate of about two per week. Repairs are in progress and negotiations have started with a new manufacturer for the supply of robust field-tolerant units for installation during the winter LHC shut-down.

The Committee also heard a report on the commissioning of the CMS experiment. Commissioning has progressed via stand-alone activities of sub-detectors alternating with global cosmic-ray runs. Successful cosmic-ray runs with no magnetic field were completed in May and June 2008.

The referees also reported on the status of the CMS computing. The Computing, Software and Analysis (CSA08) and Common Computing Readiness Challenge (CCRC08) exercises in May 2008 proved to be highly successful. CSA08 exercised three months of data-taking with two luminosity scenarios and provided the opportunity to analyze the calibration and alignment data. The CCRC08 provided extensive tests of the CMS Tier links, tested the re-processing of data at the Tier-1 centres and provided a test-bench for the Tier-2 analysis.

The LHCC took note of the CMS preparations for sustained operation. Amongst the concerns, the LHCC noted that the CMS sub-system field teams are mostly not large enough to cope with sustained operation, the long-term deployment of the experimental area management teams is precarious, and the costs for the consolidation of the infrastructure must be done using Maintenance and Operation funds.

7. REPORT FROM THE LHCb REFEREES

The LHCC heard a report from the LHCb referees, concentrating on the status of the installation and commissioning and the preparations for first physics.

The referees reported on the status of the LHCb installation and commissioning. Commissioning of the Vertex Locator (VELO) is approaching completion. The 3% of modules not yet commissioned is due to missing low voltage power supplies (late delivery) and TELL1 read-out boards (require better quality of vias). Good progress was reported on the commissioning of the Inner Tracker and Outer Tracker and the Ring Image Cherenkov detectors RICH-1 and RICH-2 are ready for the LHC start-up. Recovery of the Outer Tracker gain loss has made progress by implementing measures based on gas flushing and module heating. The vacuum quality remains a problem for some of the RICH-2 Hybrid Photon Detectors (HPDs). The issue needs to be resolved together with the manufacturing firm as the number of spares is now declining. The Calorimeter system is complete and ready for LHC start-up. The LHCC took note that the ventilation turbines for the crates that are tolerant to magnetic fields have mechanical defects. This is a common production across all experiments and repairs and a new production is being organized. Global commissioning of the LHCb experiment is progressing well. The Online System is also ready for LHC start-up. Preparations for the key physics measurements – CP Violation, rare decays and flavour physics – are also well advanced. Construction of the replacement modules for the VELO has started and full production is expected to be completed in April 2010.

8. REPORT ON THE LCG MINI-REVIEW

The LHCC heard a report on the first LHC Computing Grid (LCG) Project Mini-Review, concentrating on the general status of the project, the Application Area, the middleware, the Common Computing Readiness Challenge (CCRC08) and the LCG Fabric.

General Project Status

The LCG Project has made significant progress since the last Comprehensive Review in 2007. The basic middleware services are in place and have been improved in terms of stability and reliability. The computing capacity required for the 2008 data taking has been installed, while the installed storage capacity is only about 52% of what is required.

The CCRC08, carried out in February and May 2008, has been a reasonable success and validated the overall functionality of the system. However, the data reprocessing at the Tier-1 centres and the widespread analysis was not tested simultaneously for all the experiments.

Co-ordination and communication between experiments, the Tier-1 sites and the LCG, although improved with respect to the past, needs continuous attention and remain of crucial importance.

The pledged resources do not fully match the experiment requirements, with the significant shortfall for ALICE being noteworthy. A preliminary enquiry for pledges for 2013 has started, but it seems that a 5-year planning cycle may be questionable.

The current infrastructure, based on Enabling Grids for E-SciencE (EGEE) and Open Source Grid (OSG), is funded till 2010. The question of the long-term sustainability of the infrastructure is still unresolved, although an initial blueprint for the European Grid Initiative (EGI) project has been prepared.

Application Area

Good progress was reported in the Application Area. Specifications for the extended schema evolution in the ROOT object-oriented data analysis framework have been agreed by the experiments. The removal of the SEAL core libraries and services project dependencies in the persistency framework has been completed. Two new R&D projects have started: WP8, Parallelization of Software Frameworks to exploit Multi-core Processors and WP9, Portable Analysis Environment using Virtualization Technology.

The manpower reduction in the Application Area planned for 2009 has been brought forward to 2008. The current manpower level appears to be sufficient to support the on-going activities, but further reductions would be detrimental for the project.

Middleware

The gLite 3.1 middleware baseline services are largely in place and perform well. Some scalability issues for the LCG Computing Element (LCG-CE) and for the information system remain, however. No major upgrades are foreseen, with the main focus now on

the stability and reliability. The Computing Resource Execution and Management (CREAM) Computing Element is in the last steps of certification and should solve the scalability issues in LCG-CE.

The OSG 1.0 middleware has been released and deployed, with significant improvements in interoperability with the LCG.

The addendum to the SRM V2.2 storage resource manager has been agreed to, with the absolute minimum of additional required functionality. The short-term solution will be implementation-specific and will be realized before the end of 2008, while for the longer term, an implementation-independent full solution will be discussed only after the first experience with data.

Common Computing Readiness Challenge (CCRC08)

The results from the second phase of the CCRC08 challenge in May 2008 have shown that the experiments and the World-wide LCG (WLCG) would be in the position to handle the first LHC data in 2008. The WLCG middleware and basic services, such as the databases, are in place and functional. However, the large amount of software changes and the level of WLCG expert interventions, of the order of one per day, indicate a still rapidly-developing system.

The LHC experiments tested their computing and analysis models to various levels of complexity. The ATLAS experiment tested the data transfers between the Tier-0 and Tier-1 centres during three days with an equivalent rate of 200 Hz and with concurrent activities from the CMS experiment. Tier-1 to Tier-1 transfers, beyond the needs anticipated for 2008, were also tested during two days with transfer rates up to 90 MB/s. The CMS experiment carried out a stress test of all transfer links from Tier-0 to Tier-1 centres, which reach the required nominal rate of 600 MB/s, and from the Tier-1 to Tier-2 centres, with a total of 120 TB of data transfer per day. In addition, data were reprocessed in all Tier-1 centres, and user analyses at the Tier-2 centres were tried via both co-ordinated and chaotic submission of jobs by individual users. The LHCb experiment performed a test equivalent to one month of data taking assuming a 50% LHC efficiency. Both LHCb to Tier-0 input rates and Tier-0 to Tier-1 transfer rates were tested, reaching the required nominal rates. The ALICE experiment also tested Tier-0 to Tier-1 data transfers up to satisfactory rates, and performed well in handling 10 GB single files.

Despite the good performance of data transfers between Tier-0 and Tier-1 centres, some of the main milestones of the CCRC08 exercise, namely the study of the behaviour of the Tier infrastructure against chaotic usage of resources, and the possible interference between experiments during data reprocessing at Tier-1 centres, were not tested due, to some extent, to a lack of co-ordination among the experiments and the WLCG when planning the CCRC08 activities.

LCG Fabric

The ramp-up of Tier-0 and Calibration Analysis Facility (CAF) resources at CERN is proceeding well. Disk installations, are, however, somewhat delayed, as only 52% of the pledged disk space was installed in May 2008, and the rest is being deployed

progressively. The CASTOR mass storage system has been generally running well during CCRC08; a number of smaller incidents, however, necessitated several upgrades mainly to the SRM interface to improve its resilience. An encouraging number of performance metrics have been integrated by now, which allows for better monitoring of the system performance. This system should be further developed and improved. Generally, CASTOR operation is now more strongly exposed to the actions of individual users, whose use patterns are in contrast to the controlled production operations of the experiments, and the system is not optimized for them. Managing this kind of access needs more attention in the future.

Due to cooling power considerations, the usable floor space in Building 513 will hit hard limits by the end of 2010. Even on this time scale, aggressive retiring of old servers by new and more cooling-efficient hardware is necessary to be able to accommodate the required computing power during the LHC computing ramp-up. Planning for a new computing centre has therefore started. Nevertheless, temporary solutions are needed to bridge the time until the new center can be operational, which is not before 2012.

Most Tier-1 centres had procurement delays in 2008. While CCRC08 did not suffer noticeably, it is important to have the situation well under control for 2009, when long LHC runs are foreseen. Reliability of the sites has been improving steadily over the last half year. There are still outstanding high-level WLCG milestones: two (of 12) sites are yet to put their 24x7 support into operation, and five still need to implement a Service Level Agreement for VO boxes.

For the Tier-2 sites, the reporting scheme for installed resources needs to be improved, as it is still difficult and onerous to collect accurate information to assess the balance with respect to the pledges. Overall, the pledges are largely in the range of the requirements, only the ALICE experiment still has a significant shortfall of Tier-2 processing power. In terms of reliability, several of the Tier-2 sites have already reached an impressive average reliability of close to 95%, but the overall average is not yet acceptable. The experiments should use their leverage to control and improve their reliability, for example by hosting attractive datasets at well-performing centres, or by properly crediting the host institutions within the internal accounting system.

Overall Conclusion

The LHCC considers that the LCG Project has shown significant progress since the last Comprehensive Review in both the production and analysis phases and that the WLCG has become a reality. With the caveat of the outstanding concerns, the Committee considers that it is realistic to expect WLCG to have an initial working system ready for the start of LHC operation in 2008.

9. REPORT FROM THE LHCf REFEREES

The LHCC heard a report from the LHCf referees. Excellent progress was reported on the installation and commissioning of the LHCf experiment. Both arms of the LHCf experiment have been installed in the LHC TAN absorbers in January 2008. The LHCf DAQ is operational and the exchange of timing and other signals with ATLAS and with

the LHC accelerator is ready. LHCf plans to take data in 2008 with stable LHC conditions at luminosities less than 10^{30} cm^{-2} s^{-1}.

10. REPORT FROM THE LHC EXPERIMENT UPGRADE REVIEW

The LHCC heard a report on the LHC experiment upgrade review held by the Committee in view to a future increase in the LHC luminosity. The objective of the review was to bring together all interested constituencies from the machine and experiments in an effort to establish contacts, to agree on various scenarios defining the overall framework for such an upgrade and to define possible timescales for the upgrade of the experiments. The first stages of the LHC accelerator upgrades, which includes the realization of the full collimator system and the construction of a new linear accelerator, LINAC4, together with new interaction region final magnets, is already part of the approved programme. Plans for a further phase, based on the construction of a Superconducting Proton Linac (SPL) and a new proton synchrotron, PS2, are under development. These measures are expected to push the luminosity to a few times 10^{34} cm^{2} s^{-1} and studies are also underway to reach 10^{35} cm^{-2} s^{-1}. The referees provided an overview of the ATLAS and CMS activities and projects. An impressive number of R&D projects are underway in both ATLAS and CMS. In addition, an organized effort is underway to prepare various R&D activities that are common or generic in nature. The LHCC noted the need to obtain experience with the current experimental set-ups before finalizing choices for the upgrades. However, given the existing timescales, the time available to implement the new designs is tight. The Committee will establish referee teams that will review the experiment upgrade activities in the future. Whilst the focus of the first meeting was on the challenges that the higher luminosity places on ATLAS and CMS, future meetings will also address special challenges for the ALICE and LHCb experiments.

11. REPORT FROM THE LHC PROGRAMME CO-ORDINATOR

The LHCC heard a report from the LHC Programme Co-ordinator. He reported excellent progress in the hardware commissioning of the LHC machine. Since the previous meeting of the LHCC in May 2008, a number of key LHC milestones have been passed successfully, including the commissioning with beam of the TI2 and TI8 transfer lines and the safety tests of the access system for the TI2 and TI8 transfer lines together with the first phase for the full LHC access system commissioning. Preparations for first LHC operation are well advanced and detailed parameter settings have been finalized. Weekly meetings chaired by the LHC Programme Co-ordinator have started and are well-attended.

12. REFEREES

The LHCC referee teams are as follows:

ALICE: M. Gonin, J. Haba (Co-ordinator)

ATLAS: F. Forti, V. Kekelidze (Co-ordinator), R. Mankel, P. Mato

CMS: S. de Jong, M. Martinez-Perez, S. Smith (Co-ordinator), R. Yoshida

LHCb: S. Dalla Torre, C. Niebuhr, B. Peyaud (Co-ordinator)

TOTEM: S. Dalla Torre

MOEDAL: B. Peyaud

LHCf: M. Mangano, C. Niebuhr

RD39: S. de Jong

RD42: V. Kekelidze

RD50: R. Yoshida

LCG: F. Forti (Co-ordinator), R. Mankel, M. Martinez-Perez

13. The LHCC received the following documents:

Minutes of the ninety-third meeting held on Wednesday and Thursday, 7-8 May 2008
LHCC-2008-008/LHCC-A-093

R&D Proposal Development of Micro-Pattern Gas Detector Technologies
LHCC-2008-011/LHCC-P-001

Review of the ATLAS Technical Design Report on the Forward Detectors for the Measurement of Elastic Scattering and Luminosity
LHCC-2008-013/G-140

14. DATES FOR LHCC MEETINGS

Dates for **2008**:
24-25 September
19-20 November

Dates for **2009**:
18-19 February
6-7 May
8-9 July
23-24 September
18-19 November

Emmanuel Tsesmelis
E–mail: LHCC.Secretary@CERN.CH
Tel. 78949, 164057

LHCC Secretariat: Morna Robillard (Bldg. 3/R-012) Tel. 73224
morna.robillard@cern.ch

ANNEX 2

1/9/2008 TE

DRAFT

AD Consolidation for operation beyond 2010

1. Introduction

The Antiproton Decelerator (AD), which started up for physics in 2000 and today supplies low-energy antiprotons to the ATRAP, ALPHA, ASACUSA and ACE experiments is based on the ACOL machine from which it still retains most of the components. ACOL construction was completed in 1986 at a total cost of approximately 80 MCHF (excluding infrastructure) which today would correspond to a value of around 160 MCHF. During recent years, a reduction of maintenance and modernisation has been unavoidable due to budgetary restraints. In order to identify the resources needed for continued AD operation beyond 2010 with a reasonably low risk of failures and to avoid increasing maintenance and repair costs, a study has been conducted involving groups from the AB, AT and TS departments. Analysis of breakdown risks, identification of items and costs for consolidation has been done as well as a risk score classification. To be noted is the relatively modest cost of the proposed items in view of the value of the facility and in comparison to the cost of the manpower necessary for running AD.
The two scenarios under consideration are (1): Continued operation until the end of 2012 with no major modifications to the AD machine and (2): Operation until the end of 2016 with the possibility to implement the proposed ELENA upgrade.
In both scenarios, AEGIS can carry out the measurement that it has proposed to make. The success-oriented timeline of the AEGIS proposal, which foresees installation of the experiment in 2009 and 2010, commissioning and first data taking in 2011 and carrying-out of a first gravitational measurement with antihydrogen in the following year, is compatible with a scenario of AD operation only until the end of 2012. However, running the AD until 2016 would in addition allow going beyond the initial validation of the technique and would permit a more thorough investigation of the systematic errors in order to reach the initial physics goal (a measurement of the gravitational interaction of antihydrogen to 1%) and perhaps improve on it, as well as a number of ancillary physics
measurements which are interesting and publishable in their own right.

2. Executive summary

Identification of AD consolidation items was accomplished in collaboration with the AB, AT and TS departments. For each item, analysis of risk and implication of breakdowns was done using the method described in chapter 3. In chapter 4, a brief description of each item is given along with the estimated risk scores for the present state and for after the proposed consolidation. Also included are estimations for required manpower and materials budgets. Also included in this report are AD running cost estimates (manpower and materials), short descriptions and cost estimates for the 2 proposals AEGIS and ELENA as well as considerations for running AD beyond 2016.

Three tables are presented in this summary:

Table1 “AD risk score classification” contains items classified according to their present risk score (RS). Total Personnel and Materials budgets are given along with running summaries for the two closedown scenarios. Whether an item is to be considered for consolidation in the case of closedown in 2012 or 2016 respectively is indicated in the “1=Needed” columns.
For some items, a risk analysis is not appropriate. These are commented and grouped at the bottom of the table.
Tables 2 and 3 show for the two closedown scenarios respectively the money spending profiles during 2008 – 2012 containing only the items which are considered for each scenario.

Table 1.

AD risk score classification

Item	Group	RS	RS after	P	M	2012	2016	ΣP 2012	ΣM 2012	ΣP 2016	ΣM 2016	Remarks
						1=Needed						
				MY	kSfr			MY	kSfr	MY	kSfr	
AD Main bending magnets	AT-MCS	**15**	**6**	2.4	1030	0	1	0	0	2.4	1030	
AD power converter spares	AB-PO	**15**	**3**	0.25	95	1	1	0.25	95	2.65	1125	
AD MWPC:s	AB-BI	**15**	**2**	2	600	1	1	2.25	695	4.65	1725	ccc op&AEGIS
AD ring quadrupole QFC54	AT-MCS	**10**	**6**	0.3	60	1	1	2.55	755	4.95	1785	
AD inj. line pulsed power converters	AB-PO	**10**	**3**	4.3	1180	1	1	6.85	1935	9.25	2965	
AD e-cooling magnet spares	AB-BI	**10**	**6**	0.2	200	0	1	6.85	1935	9.45	3165	
AD target area spare magnets	AT-MCS	**10**	**4**		25	1	1	6.85	1960	9.45	3190	
AD vacuum ion pumps	AT-VAC	**9**	**6**	0.8	96	1	1	7.65	2056	10.25	3286	
AD kicker vacuum tanks	AB-BT	**9**	**2**	0.25	100	0	1	7.65	2056	10.5	3386	
AD Stoch.cooling p/u&kicker movement	AB-RF	**9**	**2**	1	50	1	1	8.65	2106	11.5	3436	
AD horn pulser ignitrons	AB-BT	**9**	**3**	0.5	400	0	1	8.65	2106	12	3836	Safety
AD vacuum cryo system	AT-VAC	**8**	**4**	0	80	1	1	8.65	2186	12	3916	
AD ring Q-trim power converters	AB-PO	**8**	**3**	1	175	1	1	9.65	2361	13	4091	
AD C02 system	AB-RF	**8**	**3**	1	160	1	1	10.65	2521	14	4251	
AD kicker oil system	AB-BT	**8**	**3**	0.75	60	0	1	10.65	2521	14.75	4311	
AD horn pulser electronics	AB-BT	**8**	**3**	0.5	100	0	1	10.65	2521	15.25	4411	
AD vac.ion pump power supplies&ctrls	AT-VAC	**8**	**2**	0.4	350	1	1	11.05	2871	15.65	4761	
AD target area ventilation & interlocks	AB-OP	**8**	**3**	1	100	1	1	12.05	2971	16.65	4861	
AD Stochastic cooling electronics	AB-RF	**6..9**	**2**	0.5	100	1	1	12.55	3071	17.15	4961	
AD ring corrector dipoles	AT-MCS	**6**	**4**	0.3	60	1	1	12.85	3131	17.45	5021	
AD magnet ancillary equipment	AT-MCS	**6**	**2**	0.3	135	0	1	12.95	3176	17.75	5156	
AD electron cooler power converters	AB-PO	**6**	**3**	0.5	100	1	1	13.45	3276	18.25	5256	
AD target water cooling	AB-OP	**6**	**4**		50	1	1	13.45	3326	18.25	5306	
AD ejection line power converters	AB-PO	**4**	**2**	0.25	90	0	1	13.45	3326	18.5	5396	
AD Stochastic cooling power amplifiers	AB-RF	**4**	**2**	1.5	2500	0	0	13.45	3326	18.5	5396	2020
AD C10 system	AB-RF	**4**	**2**	0.2	75	1	1	13.65	3401	18.7	5471	
AD kicker power supply/ctrls upgrade	AB-BT	**4**	**2**	0.25	125	0	1	13.65	3401	18.95	5596	
AD orbit measurement system	AB-BI	**3**	**1**	0.1	65	1	1	13.75	3466	19.05	5661	
AD beam current transformers	AB-BI	**3**	**1**	1	230	1	1	14.75	3696	20.05	5891	
AD Instrumentation SW + FSU	AB-BI	**3**	**1**	1	80	1	1	15.75	3776	21.05	5971	
AD main quadrupole magnets	AT-MCS	**3..4**	**N.A.**			0	0	15.75	3776	21.05	5971	No suggestions
AD injection&ejection septa	AB-BT	**3**	**N.A.**			0	0	15.75	3776	21.05	5971	No suggestions
AD Stochastic cooling vacuum tanks	AB-RF	**5**	**N.A.**			0	0	15.75	3776	21.05	5971	No suggestions
Items without risk score rating:												
AD controls	AB-CO	**N.A**	**N.A**	5	700	1	1	20.75	4476	26.05	6671	CO program with AD controls
AD septa controls	AB-BT	**N.A.**	**N.A.**	0.4	25	1	1	21.15	4501	26.45	6696	
AD beam control	AB-RF	**N.A.**	**N.A.**	2.35	100	0	1	21.15	4501	28.8	6796	R.O.I.
AD target area remote manipulation	AB-ATB	**N.A.**	**N.A.**	0.75	45	1	1	21.9	4546	29.55	6841	R.O.I.
AD cooling/ventilation	TS-CV				60	1	1	21.9	4606	29.55	6901	to be discussed
AD schottky analysis	AB-RF/BI					0	0	21.9	4606	29.55	6901	to be discussed
Total								**21.9**	**4606**	**29.6**	**6901**	

Table 2.
Spending profile 2012 closedown

Item	Group	RS	RS after	ΣP	ΣM	M08	M09	M10	M11	M12
				MY	kSfr	kSfr	kSfr	kSfr	kSfr	kSfr
AD power converter spares	AB-PO	15	3	0.25	95		47	48		
AD MWPC:s	AB-BI	15	2	2	600		300	300		
AD ring quadrupole QFC54	AT-MCS	10	6	0.3	60		60			
AD injection line pulsed power converters	AB-PO	10	3	4.3	1180		120	530	530	
AD target area spare magnets	AT-MCS	10	4		25		25			
AD vacuum ion pumps	AT-VAC	9	6	0.8	96	24	24	24	24	
AD Stochastic cooling p/u & kicker movement	AB-RF	9	2	1	50		50			
AD vacuum cryo system	AT-VAC	8	4	0	80	20	20	20	20	
AD ring Q-trim power converters	AB-PO	8	3	1	175		25	150		
AD C02 system	AB-RF	8	3	1	160			80	80	
AD vacuum ion pump power supplies&controls	AT-VAC	8	2	0.4	350	50	150	150		
AD target area ventilation & interlocks	AB-OP	8	3	1	100			100		
AD Stochastic cooling electronics	AB-RF	6..9	2	0.5	100		50	50		
AD ring corrector dipoles	AT-MCS	6	4	0.3	60			60		
AD magnet ancillary equipment	AT-MCS	6	2	0.1	45		45			
AD electron cooler power converters	AB-PO	6	3	0.5	100		100			
AD target water cooling	AB-OP	6	4		50		50			
AD C10 system	AB-RF	4	2	0.2	75			75		
AD orbit measurement system	AB-BI	3	1	0.1	65			65		
AD beam current transformers	AB-BI	3	1	1	230				230	
AD Instrumentation SW + FSU	AB-BI	3	1	1	80			40	40	
Items without risk score rating:										
AD controls	AB-CO	N.A	N.A	5	700			500	200	
AD septa controls	AB-BT	N.A.	N.A.	0.4	25			25		
AD target area remote manipulation	AB-ATB	N.A.	N.A.	0.75	45			45		
AD cooling/ventilation	TS-CV				60			60		
AD schottky analysis	AB-RF/BI									
Yearly total (kSfr)						**94**	**1066**	**2322**	**1124**	**0**
Grand total (kSfr)					**4606**					

Table 3.
Spending profile 2016 closedown

Item	Group	RS	RS after	ΣP MY	ΣM kSfr	M08 kSfr	M09 kSfr	M10 kSfr	M11 kSfr	M12 kSfr
AD Main bending magnets	AT-MCS	15	6	2.4	1030		10	420	300	300
AD power converter spares	AB-PO	15	3	0.25	95		47	48		
AD MWPC:s	AB-BI	15	2	2	600		300	300		
AD ring quadrupole QFC54	AT-MCS	10	6	0.3	60		60			
AD injection line pulsed power converters	AB-PO	10	3	4.3	1180		120	530	530	
AD e-cooling magnet spares	AB-BI	10	6	0.2	200			80	120	
AD target area spare magnets	AT-MCS	10	4		25		25			
AD vacuum ion pumps	AT-VAC	9	6	0.8	96	24	24	24	24	
AD kicker vacuum tanks	AB-BT	9	2	0.25	100				50	50
AD Stochastic cooling p/u&kicker movement	AB-RF	9	2	1	50		50			
AD horn pulser ignitrons	AB-BT	9	3	0.5	400					400
AD vacuum cryo system	AT-VAC	8	4	0	80	20	20	20	20	
AD ring Q-trim power converters	AB-PO	8	3	1	175		25	150		
AD C02 system	AB-RF	8	3	1	160			80	80	
AD kicker oil system	AB-BT	8	3	0.75	60			30	30	
AD horn pulser electronics	AB-BT	8	3	0.5	100					100
AD vacuum ion pump power supplies&controls	AT-VAC	8	2	0.4	350	50	150	150		
AD target area ventilation & interlocks	AB-OP	8	3	1	100			100		
AD Stochastic cooling electronics	AB-RF	6..9	2	0.5	100		50	50		
AD ring corrector dipoles	AT-MCS	6	4	0.3	60			60		
AD magnet ancillary equipment	AT-MCS	6	2	0.3	135		45	45	45	
AD electron cooler power converters	AB-PO	6	3	0.5	100		100			
AD target water cooling	AB-OP	6	4		50		50			
AD ejection line power converters	AB-PO	4	2	0.25	90				90	
AD C10 system	AB-RF	4	2	0.2	75			75		
AD kicker power supply/controls upgrade	AB-BT	4	2	0.25	125				62	63
AD orbit measurement system	AB-BI	3	1	0.1	65			65		
AD beam current transformers	AB-BI	3	1	1	230				230	
AD Instrumentation SW + FSU	AB-BI	3	1	1	80			40	40	
Items without risk score rating:										
AD controls	AB-CO	N.A	N.A	5	700			500	200	
AD septa controls	AB-BT	N.A.	N.A.	0.4	25			25		
AD beam control	AB-RF	N.A.	N.A.	2.35	100			50	50	
AD target area remote manipulation	AB-ATB	N.A.	N.A.	0.75	45			45		
AD cooling/ventilation	TS-CV				60			60		
AD schottky analysis	AB-RF/BI									
Yearly total (kSfr)						**94**	**1076**	**2947**	**1871**	**913**
Grand total (kSfr)					**6901**					

3. Risk analysis of the AD systems

- Risk analysis

A risk analysis has been performed for each item partly using the standard method of the AB department. Since this analysis reflects AD-only consolidation needs, the coefficient defining the importance of the AD physics program in relation to the other CERN programs has been omitted.
The risk analysis includes the following data:

1. Probability of failure (P)

- Rare (once in 10 to 25 years) = **1**
- Possible (once in 5 to 10 years) = **2**
- Likely (once in 2 to 5 years) = **3**
- Frequent (once a year) = **4**

2. Impact on CERN scientific objectives (Io)

- Insignificant (loss of 1 day of physics or less) = **1**
- Moderate (between 1 day and 1 week of physics lost) = **2**
- Major (up to 1 month of physics lost) = **3**
- Catastrophic (no more operation, failure to meet objectives for the year) = **5**

3. Impact on CERN's (AB department's) reputation (Ir)

- Insignificant = **1**
- Moderate (problem dealt with inside AB) = **2**
- Major (problem discussed at Executive Board or Governing bodies) = **3**

4. Financial impact of failure (If)

- Insignificant (<0.5% of AB annual budget or less than 120 kCHf) = **1**
- Moderate (between 1% and 4% of AB annual budget or 0.25 – 1 MCHf) = **2**
- Major (additional budget essential for repair i.e. >1MCHf) = **3**
- Catastrophic (report to council, could jeopardize CERN's future) = **5**

5. Safety impact in case of failure (Is)

- Insignificant (i.e. no injury or environmental consequence) = **1**
- Moderate (i.e. injury requiring medical attention but no loss of working days) = **2**
- Major (i.e. serious injury requiring medical attention and loss of working days)= **3**
- Catastrophic (i.e. loss of life) = **5**

The risk score is calculated as : **RS = P*max(Io,Ir,If,Is)**

4. Items considered for consolidation

- AD Magnets:

Money made available via consolidation projects for a total sum of 1.29 MCHF over the next 4 to 5 years. This will cover the purchase of spare magnet components, coils etc... and to rebuild the magnets, as well as the occasional routine maintenance which exceeds the frame of paragraph 1.Hereunder is the proposed baseline for a possible forthcoming AD consolidation program.
An inventory of the spare situation for the transfer line magnets is near completion. With a few exceptions, spares are available.
Conclusion: There are 177 magnets in operation in the AD Ring and its TL. Only a fraction (~ 80)of these magnets could be assessed in a relatively correct way due to the limited resources available. However the recommendations drafted in the present document should prevent the major foreseeable failures.

Item: AD Main bending magnets BHN/BHW/BHS
Responsible: AT/MCS
Description: Supply of 5 sets of spare coils (2N, 2W, 1S)
Supply of tools to machine open the magnets
Overhaul of 4 magnets in 2010, 10+10 magnets in 2011/2012
RS: 15 (P=3, Io=5, Ir=2, If=2, Is=1)
RS after cons.: 6 (P=2, Io=3, Ir=2, If=1, Is=1)
Total budget: 1030 kSfr + 2.4 MY 2010-2012

The 24 BHN/BHW/BHS dipoles constitute the main magnets of the AD ring. The coil shimming of these dipoles shows an abnormal degradation, which tends to indicate that the coils are moving inside the magnet yokes during the pulsed cycle. It is therefore recommended to undertake the replacement of the internal shimming for some or all of the 24 dipoles. This entails the complete disassembly of the magnets. If such a program is undertaken it is advisable to also assess the coil insulation quality, as well as the possibility of the magnetic properties of the magnets. Such an important overhaul can be achieved within a 3-years program (Shutdown 2009/10 to 2011/12). Spare coils will be required in case of failure during the tests, and if the overhaul of the magnets is not conducted should be seen as a minimum requirement.
Note: A breakdown of one of the main dipoles cannot be excluded in the coming years. There are no spare BHN/BHW/BHS magnets available. The tooling required to replace a damaged coil is not available. There are no spare Coils available.
Note 2: Further evaluation of the Risk Score based on coil movement measurements and stress analysis of the coil connection pieces will be done during the 2008/9 shutdown. This might change the estimated RS downwards.

Item: AD Main quadrupole magnets QN(15/17/19 turns) & QW(20/22/26 turns).
Responsible: AT/MCS
Description: None
RS: 3/4 (P=1/2, Io=2/3, Ir=2, If=2, Is=1)
RS after cons.: N.A.
Total budget: N.A.
Remark: *Item for information on risk analysis*

The main ring quadrupoles (27 QN / 28 QW) are in an assessed good state and should not require a specific consolidation program in the near future. Spare magnets and coils are available for most types. A risk analysis has been drafted in the annex for information. Although, two minor issues have been identified that could possibly justify future actions:

- The possible movement of the upper coils (in case of accelerated ageing of the coil shimming) could overstress the straight and rigid interconnection between the coils and lead to the failure of the cooling circuit. Such phenomenon's have already been observed in the past, and a modification was undertaken several years ago (extra shimming) that might still be require further attention in the long term;
- The quadrupole coil tensioning rods made of conductive material are in contact with the coil insulation. In case of coil movement, this setup could eventually damage the coil insulation and lead to ground shorts.

Item: AD ring corrector dipoles
Responsible: AT/MCS
Description: Design and supply of correctors (functionality upgrade for DVD/DHZ 2904 and DVT/DHZ 2917). Supply of spare coils
RS: 6 (P=2, Io=3, Ir=1, If=1, Is=1)
RS after cons.: 4 (P=2, Io=2, Ir=1, If=1, Is=1)
Total budget: 60 kSfr + 0.3 MY 2010

Correctors are in much worse state and are probably much less reliable than any other element of the magnetic system of AD. The AD section has already expressed their wish to upgrade the correctors upstream and downstream the electron cooler (DHZ2904 / DHZ2917). In addition it is recommended either to renovate some other correctors in place in the ring and in the TL with new coils or to develop new correctors. The later program would require further studies.

Item: AD ring quadrupole QFC54
Responsible: AT/MCS
Description: Supply of 1 set of spare coils
RS: 10 (P=2, Io=5, Ir=2, If=1, Is=1)
RS after cons.: 6 (P=2, Io=3, Ir=2, If=1, Is=1)
Total budget: 60 kSfr + 0.3 MY 2009

The recent breakdown of the QFC054 magnet has imposed its overhauling and the replacement of its original coils with the only spare coils available. During the refurbishment,

it has been noticed that the design of the cooling junctions has not been optimized for the very high speed of the water in this region (endoscopic examination inside the coil). It was also noticed that the old coils had already undergone several repairs at this junction before its complete wreckage during 2007 run. It is clear that the spare set of coils that is now put in place will suffer similar fast erosion in this region. It is recommended to manufacture a set of spare coils with an improved design in case this magnet is supposed to run for an extended period of time.

Item: AD magnet ancillary equipment
Responsible: AT/MCS
Description: Installation of filters + flow measurement on 80 main magnets
Replacement of 300 water hoses
RS: 6 (P=3, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 2 (P=1, Io=2, Ir=1, If=1, Is=1)
Total budget: 135 kSfr + 0.3 MY 2009-2011

Most of the magnet ancillary equipment is in relative good shape and as such would not require any specific consolidation.
It is noted that water hoses have a limited lifetime (usually 10-15 years). In absence of information amongst AT/MCS, the age of the existing hoses could not be evaluated. The replacement of the hoses might have to be foreseen in the coming years. According to AD machine experts these hoses could already be aged between 10 and 15 years. If such is the case a replacement should be foreseen within 5 years if AD is to be run beyond 2012.
It is noted that no water filters equip the dipoles and quadrupoles in the AD Ring. Although not mandatory, filters guarantee that no impurity can enter and clog the magnet cooling circuits. Being given the spare situation of the main magnets, it might be safe to foresee the installation of filters on the magnets.

Estimated cost for filters & flowmeasurement is: 15kSfr HW + 30 kSfr FSU + 0.1 MY in 2009
Cost for water hoses is: 70kSfr HW + 20 kSfr FSU+ 0.2 MY spread over 2010 & 2011

- AD power converters:

Item: AD injection line pulsed power converters
Responsible: AB/PO
Description: Replace existing pulsed converters with up-to-date
RS: 10 (P=4, Io=2/3, Ir=2, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 1180 kSfr + 4.3 MY 2009-2011

The existing 2/4 kA converters are of the capacitive discharge type which employs large numbers of electrolytic capacitors. With an age of around 30 years, fault rates are increasing and faults cause long delays. A new design is proposed which retains some of the existing electronics. Design and prototyping will require 120 kSfr and 0.5 MY during the first year.

Production of the 12 + 1 spare units is budgeted at 13* 70 kSfr + 30% (for controls, electricity supply and FSU:s).Manpower needs are 3.5 man-months per unit spread over the two following years.
Total budget of 1180 kSfr + 4.3 MY over 3 years 2009-2011.

Item: AD ring Q-trim power converters
Responsible: AB/PO
Description: Q-trim converters upgrade/simplifying.
RS: 8 (P=4, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 175 kSfr + 1 MY 2009-2010

Modification of existing Danfysik converters (Q-trim 1-2-3-5 and B-trim) to ensure future serviceability. Prototyping/tests of 1 unit foreseen in 2009 and installation of remainder as of 2010. At a price of 25 kSfr each , cost is 125 kSfr.
Replacement of ageing Q-trim4 with a new unit = 50 kSfr.
Manpower needs of 1 MY over 2 years.

Item: AD power converter spares
Responsible: AB/PO
Description: BTI274S spare components and cabling, B/Q spares
RS: 15 (P=3, Io=5, Ir=2, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 95 kSfr + 0.25 MY 2009-2010

No spare unit exists for the BTI247S switching dipole converter (TT2 to AD target). The proposed solution consists of using a similar converter installed in B.355 via new cables, modification of this converter to comply with the high inductance of the magnet and also the purchasing of spare components. A budget of 70kSfr has to be foreseen.
Also included is the purchase of spare parts for B-main and Q-main converters at a cost of 25kSfr.
Total budget is 95kSfr + 3 MM during 2009-2010.

Item: AD ejection line power converters
Responsible: AB/PO
Description: Replacement of ageing converters.
RS: 4 (P=2, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 90 kSfr + 0.25 MY 2011

10 of the converters for the ejection line magnets are old and are getting difficult to maintain in a good operational state. Foreseen is the replacement with new units at a total budget of 90 kSfr + 3 MM in 2011.

Item: AD electron cooler power converters
Responsible: AB/PO (AB/BI)
Description: Replace existing e-beam corrector converters with up-to-date
RS: 6 (P=3, Io=2, Ir=1, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 100 kSfr + 0.5 MY 2009 (*)

Existing electron beam trajectory corrector supplies are of an old type with uncertain future spare situation. The proposed consolidation consists of replacing the existing supplies with modern units also capable of switching polarity during the machine cycle. Cost is15*5kSfr + 30% for spares and cabling.
Budget is 100 kSfr + 0.5 MY over one year.

(*) Following items have been started in 2008 using the existing AD consolidation budget:
Replacement of 3 FUG supplies on the e-cooler platform due to lack of documentation of modifications and also lack of spares. Cost is (3*6 kSfr + 30%).
The consolidation also includes replacement of an obsolete oil-filled 40kV isolation transformer with a standard unit of the same type as is used in LEIR.(20 kSfr).
Advantage of replacing the old G64 by a new PLC-system will be taken by upgrading the e-cooler interlock system, this will add 10kSfr + 0.2 MY.

- AD beam cooling:

Item: AD electron cooler magnet spares
Responsible: AB/BI
Description: Manufacture of 3 spare coils
RS: 10 (P=2, Io=5, Ir=3, If=2, Is=1)
RS after cons.: 6 (P=2, Io=3, Ir=2, If=1, Is=1)
Total budget: 200 kSfr + 0.2 MY 2010-2011

Since no spare units exist for some of the magnetic elements, a major breakdown would cause up to 1 year stop of physics. Consolidation consists of manufacture of 1 toroid, 1 collector solenoid and 1 gun solenoid. Replacement of any of these units require dismantling of the e-cooler and subsequent vacuum bakeout, hence the rather high RS after consolidation.
Budget is 200 kSfr + 2 MM over 2 years (2010/2011).

Item: AD Stochastic cooling power amplifiers
Responsible: AB/RF
Description: Construction of new power amplifiers & power supplies
RS: 4 (P=4, Io=1, Ir=1, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 2.5 MSfr + 1.5 MY 2011-2012
Remark: *Only in the case of AD running beyond 2016*

This item concerns the 48 semiconductor power amplifiers. It is estimated that with the present failure rate of approximately 10/yr and taking into account the present spare

component stock and maintenance scheme that the system can be maintained until 2016. AD physics will stop if a large number of these 3GHz bandwidth amplifiers drop out. For the period 2016 until 2020, one can expect increasing failure rates and depletion of the spare component stock. In this case, a renovation of the system should be considered including the design and construction of new amplifiers and power supplies. Required budget amounts to 2.5 MSfr + 1.5 MY spread over 2011 and 2012. Yearly maintenance which requires 10 kSfr HW + 15 kSfr FSU + 0.1 MY would be halved.

Item: AD Stochastic cooling vacuum tanks
Responsible: AB/RF
Description: N/A
RS: 5 (P=1, Io=5, Ir=3, If=3, Is=1)
RS after cons.: N.A.
Total budget: N.A.
Remark: *Item for information on risk analysis*

In 1999 one of the kicker tanks water cooling circuits sprung a leak (inside the vacuum tank). This was successfully repaired with liquid epoxy and has been in service since then. For further possible faults of the same nature, similar repairs could be considered. In case of failed repair attempts, the implications would be very serious. All 4 tanks are required for AD operation and no spares exist at CERN. A possible solution would be requesting the return of the remaining 8 tanks (out of the 12 that were originally built for the ACOL project) from Germany and Japan and refurbish them with new technology. This would still imply high costs and manpower needs. For comparison, the 1986 price for the 12 tanks was in the order of 10 MSfr.

Item: AD Stochastic cooling electronics
Responsible: AB/RF
Description: Replacement of modified CAMAC-equipment with up-to-date
RS: 6/9 (P=3, Io=2/3, Ir=2, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 100kSfr + 0.5 MY 2009-2010

The switching of 12/24V 1A signals for system parameter control employs modified CAMAC-equipment. A replacement with up-to-date with solid-state units with standard controls interface is foreseen. The requirement is for a control with a precision of better than 100 ms with respect to the machine timing. A choice on the technical implementation has not been made yet. A PLC based system seems the most economic solution. However, it must be shown that the timing constraints can be fulfilled by a PLC. It is urgent to replace the obsolete CAMAC equipment, preferably during the 2009/10 shutdown.

Item: AD Stochastic cooling p/u & kicker movement
Responsible: AB/RF
Description: Replace motor driver electronics.
RS: 9 (P=3, Io=3, Ir=2, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)

Total budget: 50 kSfr + 1 MY 2009

Consolidation of the movement system consists of development or purchase of new motor driver electronics and associate electronics to interface with the Controls System. The requirement is for a control with a precision of better than 100 ms with respect to the machine timing. A choice on the technical implementation has not been made yet. A PLC based system seems the most economic solution. However, it must be shown that the timing constraints can be fulfilled by a PLC. Spare mechanical parts for this system are presently available from de-commissioned units. This work could be done in 2009.

- AD RF equipment:

Item: AD C10 system
Responsible: AB/RF
Description: Replacement of 1kW amplifiers.
RS: 4 (P=4, Io=1, Ir=1, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 75 kSfr + 0.2 MY 2010

Several of the consolidation items from previous consolidation program have already been done. Major remaining item is replacement of the 1kW amplifiers which have caused several stops in recent years. During 2008, validation tests on an existing amplifier design will be done. Purchase of 3 units at 25 kSfr/pce is planned for 2010 and installation foreseen for the 2010/2011 shutdown. Note that the risk factor is low due to redundancy. Two C10 cavities are installed. In case of breakdown of one cavity, the AD will run at approximately 75% of nominal beam intensity.

Item: AD C02 system
Responsible: AB/RF
Description: Upgrade of obsolete equipment
RS: 8 (P=4, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 160 kSfr + 1 MY 2010-2011

A modernisation of the obsolete cavity tuning loop amplifier and power supply is urgently needed. One additional reason being the re-organising of support staff. The existing system is around 40 years old and frequently causes stops and repairs. A new design has been launched in the PS and validation for use of this design could be done in about 1 year. Estimated cost is 65 kSfr. The C02 consolidation also includes new HT supply (35 kSfr) + gap capacitors and electronics to a cost of approximately 60 kSfr. Budget is spread over 2 years 2010-2011.

Item: AD beam control
Responsible: AB/RF
Description: Upgrade of obsolete equipment
RS: **N.A.**
RS after cons.: **N.A.**
Total budget: 100 kSfr + 2.35 MY 2010-2011

Upgrade of existing analog beam control system to a standard digital low-level RF system similar to the one used in LEIR. Technical solution will depend on the future AD cycle generation/timing system.
Risk analysis is not meaningful since the objective here is standardisation and to have better remote control/analysis possibilities. Return on investment = reduced risk of long down time, no need for time consuming maintenance & repair of obsolete modules (a guess would be 0.1FTE/year of operation).
Total budget is 100 kSfr and 2.35 MY spread over 2010 and 2011. A reduction in manpower needs compared to the initial consolidation plan has been obtained since part of the development can be shared with other consolidation activities.

- AD beam transfer equipment:

Item: AD kickers oil system
Responsible: AB/BT
Description: Oil system consolidation
RS: 8 (P=4, Io=2, Ir=1, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 60 kSfr + 0.75 MY 2010-2011

Replacement of obsolete kicker oil system as part of an ongoing campaign. Requires 60 kSfr + 0.75 MY during 2010/2011.

Item: AD kicker vacuum tanks
Responsible: AB/BT
Description: Refurbishment of existing tanks
RS: 9 (P=3, Io=3, Ir=2, If=1, Is=1)
RS after cons.: 2 (P=1, Io=2, Ir=1, If=1, Is=1)
Total budget: 100 kSfr + 0.25 MY 2011-2012

Based on previous AD experience of a leak followed by successful repair, the proposed consolidation consists of refurbishment of the 3 existing tanks in machine sectors 35,55 and 56. Structural improvements will allow for 300 degrees bakeout instead of 150 and also lower the risk of failure. A budget of 100 kSfr for HW + FSU and 0.25 MY is foreseen for 2011/12.

Item: AD kicker power supply/controls upgrade
Responsible: AB/BT
Description: Replacement of obsolete equipment
RS: 4 (P=4, Io=1, Ir=1, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 125 kSfr + 0.25 MY 2011-2012

Replacement of the power supplies including controls interface for the 10 kicker modules with up-to-date equipment (PCI-crate based). Budget is 125 kSfr + 0.25 MY in 2011/12.

Item: AD horn pulser ignitrons
Responsible: AB/BT
Description: Replacement of aging mercury ignitrons with semiconductor switches.
RS: 9 (P=3, Io=2, Ir=1, If=2, Is=3)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 400 kSfr + 0.5 MY 2012
Remark: ***Safety***

Phasing out of the mercury ignitrons with semiconductor based technology. Due to the environmental impact of a failure, this item has high priority. A budget of 400 kSfr + 0.5 MY is required during 2012 or earlier if BT resources will be available. The scheduling of this item is linked with the "horn pulser electronics" upgrade below.

Item: AD horn pulser electronics
Responsible: AB/BT
Description: Replacement of obsolete purpose built equipment
RS: 8 (P=4, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 100 kSfr + 0.5 MY 2012 (*)

Consolidation of the trigger generation system, HV supply and electrical distribution should be made at the same time as the ignitron upgrade (see above). A budget of 100 kSfr + 0.5 MY is planned during 2012 (or possibly earlier).
(*) Replacement of the controls interface & electronics with standard PLC-based equipment is underway and planned to be done during 2008 using the existing AD consolidation budget (75 kSfr + 0.5MY).

Item: AD injection & ejection septa spares
Responsible: AB/BT
Description: None
RS: 3 (P=1, Io=3, Ir=1, If=1, Is=1)
RS after cons.: N.A.
Total budget: N.A.
Remark: *Item for information on risk analysis*

1 spare injection unit exists. The installed ejection septum is presently used without water cooling due to a leak. It will be dismounted during the 2008/9 shutdown and refurbished. Spare coils exist. In the case of ejection septum breakdown, 3 weeks downtime can be expected due to vacuum bakeout.

Item: AD injection & ejection septa controls
Responsible: AB/BT
Description: Upgrade of controls interface
RS: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 25 kSfr + 0.4 MY

To be considered within a global AD controls consolidation.

- AD vacuum:

Item: AD vacuum ion pump power supplies & controls
Responsible: AT/VAC
Description: Replacement of old supplies + upgrade to up-to-date controls
RS: 8 (P=4, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 350 kSfr + 0.4 MY 2009-2011

Replacement of aging Ion pump power supplies including controls (PLC/profibus based). With an age of 25 – 30 years, these supplies break down frequently. Only a few spare units exist and soon broken units will have to be repaired instead of replaced with long delays as result. For the risk analysis, AD is considered down when 1 vacuum sector is out. Budget is spread over 2009-2011.

Item: AD vacuum ion pumps
Responsible: AT/VAC
Description: Replacement of pumps and connectors
RS: 9 (P=3, Io=3, Ir=2, If=1, Is=1)
RS after cons.: 6 (P=2, Io=3, Ir=1, If=1, Is=1)
Total budget: 96 kSfr + 0.8 MY 2008-2011

Simultaneous problems with leaking connectors and/or internal short circuits on 2-3 ion pumps in the same vacuum sector will stop AD physics. Consolidation includes progressive replacement of all pumps after current measurement and replacement of connectors (10 per sector). Note that the risk score after consolidation remains fairly high due to bake-out time. Program will run over 4 years 2008-2011.

Item: AD vacuum Cryo compressors
Responsible: AT/VAC
Description: Purchase of spare units
RS: 8 (P=4, Io=2, Ir=1, If=1, Is=1)
RS after cons.: 4 (P=2, Io=2, Ir=1, If=1, Is=1)
Total budget: 80 kSfr (manpower needs are negligible) 2008-2011

Progressive (over 4 years) purchase of spare compressors.

- AD diagnostics:

Item: AD orbit measurement system
Responsible: AB/BI
Description: Purchase of spare network analyser & construct spare multiplexer
RS: 3 (P=1, Io=3, Ir=2, If=1, Is=1)
RS after cons.: 1 (P=1, Io=1, Ir=1, If=1, Is=1)
Total budget: 65 kSfr + 0.1 MY 2010

Spare part situation is satisfactory except for the multiplexer which is of an old design with obsolete components. A re-design & construction of a spare unit is foreseen (15 kSfr + 0.1MY). Included is also purchase of a spare network analyser at 50 kSfr.

Item: AD beam current transformers
Responsible: AB/BI
Description: Reconstruction of sensor and electronics of TFA6006 & TFA5302
RS: 3 (P=1, Io=3, Ir=2, If=1, Is=1)
RS after cons.: 1 (P=1, Io=1, Ir=1, If=1, Is=1)
Total budget: 230 kSfr + 1 MY 2011

Mechanical study for reconstruction of 2 TFAs. TFA6006 is situated immediately downstream of the production target and has thus received large doses of radiation. Design includes shielding issues. For both TFA:S, the electronics is out of date and needs to be replaced. Cost is 160 kSfr for 6006 and 70 kSfr for 5302 out of which a large portion is used by the design office. A total of 1 MY is required for both units.

Item: AD MWPC:s (Multi Wire Proportional Chamber)
Responsible: AB/BI
Description: Replace existing MWPC:s with GEM-detectors + new electronics
RS: 15 (P=3, Io=5, Ir=3, If=2, Is=1)
RS after cons.: 2 (P=2, Io=1, Ir=1, If=1, Is=1)
Total budget: 600 kSfr + 2 MY 2009-2010
Remark: *Improved operation from ccc.*

Upgrade of existing monitors while retaining the old vacuum chambers. Replacement of obsolete in-house developed readout electronics with standard VME-based equipment. This is an essential tool used frequently for position and profile measurements when setting-up and tuning the AD ejection lines. Using MWPCs for the low-energy AD beams causes erratic measurements in one of the two planes. The new GEM-technology will remedy this. The present spare part situation is also critical with no spares remaining for several of the electronic modules. A new system will make use practical from the CCC thanks to adequate remote control and acquisition.
N.B. The AEGIS cost estimate assumes that this MWPC upgrade is to be done since the existing MWPC system does not allow for additional channels.

- Instrumentation software + other:
To the above items one has to add 1 MY for software development/adaption + 80 kSfr (FSU) 2010-2011

-**MTV/Cameras**, AB/BI: PS-complex wide consolidation of HW & FESA compatible controls is recently done. AD equipment is up-to-date.

-**Emittance measurement,** (scrapers + stepping motors), AB/ATB: Ctrls upgrade done. Motor drivers to be replaced in 2009 (3kSfr+0.5MM).

(photomultipliers + acquisition), AB/?: Some sw effort needed for FESA compatibility. 5kSfr for spare acquisition module.

- **Schottky analysis:** Under discussion AB/RF – AB/BI. Waiting for input.

- AD target area and associated equipment:

Item: AD target area spare magnets
Responsible: AB/MCS
Description: Assessment/refurbishment of FTA.BHZ6024 spare
RS: 10 (P=2, Io=5, Ir=3, If=1, Is=1)
RS after cons.: 4 (P=2, Io=2, Ir=1, If=1, Is=1)
Total budget: 0 /25 kSfr 2009

The target area magnet spare situation is satisfactory except for FTA.BHZ6024. The spare unit for BHZ6024 and 6025 is currently installed in the 6024 location and the condition of the original magnet is not known. An assessment will be made ASAP. Depending on the condition, it might be necessary to fabricate spare coils.

Item: AD target area ventilation & interlocks
Responsible: AB/ATB
Description: Renovation of ventilation & safety interlock system
RS: 8 (P=4, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 3 (P=3, Io=1, Ir=1, If=1, Is=1)
Total budget: 100 kSfr + 1 MY 2010

The frequency of failures has increased during the last few years. The equipment is getting obsolete and lacks spare parts and documentation. Proposed consolidation includes: development of new PLC-based interlock system (20 kSfr), replacement of the ventilation controls cupboard (60 kSfr) and doubling of the controlled leak ventilator and controls (20 kSfr). Total manpower needs is around 1 MY.

Item: AD target water cooling
Responsible: AB/ATB
Description: Purchase of new sealed water pump & controls improvement
RS: 6 (P=3, Io=2, Ir=2, If=1, Is=1)
RS after cons.: 4 (P=2, Io=2, Ir=1, If=1, Is=1)
Total budget: 50 kSfr 2009

Purchase of sealed water pump: 20 kSfr. New controls: 30 kSfr

N.B. either of the 2 above items could be done during the 2008/9 shutdown, the other the following year.

Item: AD target area remote manipulation
Responsible: AB/ATB
Description: Improvement of remore manipulation equipment
RS: N.A.
RS after cons.: N.A.
Total budget: 45 kSfr + 0.75 MY 2010

The state of the equipment used for remote movements of the target, horn and associated equipment is degraded. In order to bring it back up to an acceptable state, the following actions should be considered:
Improvement of the cameras used for visual observation (15 kSfr)
Rejuvenation of manipulation equipment/electronics (20 kSfr)
Installation of a GSM antenna (10 kSfr?

-AD control system:

Item: AD control system
Responsible: AB/CO
Description: Upgrade to comply with the rest of the PS-complex
RS: N.A.
RS after cons.: N.A.
Total budget: 700 kSfr + 5 MY

In order to comply with the ongoing rejuvenation of the injector controls according to the new Inca standard, the AD control system could profit from this resource investment and be upgraded with a relatively small additional manpower effort. Continued operation with the old system is a problem since AB/CO can not afford to support all the legacy systems. The gain in manpower and also the quality of service would be much higher after renovation. For the HW, a complete upgrade of all FrontEnds is foreseen.
Major budget items:
FEs HW including crates, modules, cabling and FSUs: 700 kSfr + 2 MY of CERN manpower.
Central timing upgrade: 8 MM.
Inca DB configuration: 1.5 – 2 MY
DB support: 3 MM

N.B. HW cost could be reduced by 200 kSfr if one decides to keep existing G64 crates

-AD infrastructure:

Item: AD cooling water
Responsible: TS/CV
Description: spares + cooling tower repair
RS:
RS after cons.:
Total budget: 60 kSfr +

5. Maintenance & Operation

The following estimations have been done for actual yearly maintenance of the systems which are considered for consolidation:

Equipment	Responsible	Cost(kSfr)/yr	FTE/yr
AD magnets	AT/MCS	65	0.1
AD e-cooler	AB/BI	15	0.3
AD power converters	AB/PO	50	0.7
AD stochastic cooling	AB/RF	25	0.1
AD C10 system	AB/RF	0	0.1
AD C02 system	AB/RF	0	0
AD kickers	AB/BT	12	0.5
AD horn pulser	AB/BT	5	0.1
AD septa	AB/BT	8	0.2
AD vacuum	AT/VAC	35(*)	0.8 to 1.0
AD target area	AB/ATB	20	0.1

(*)not from AT/VAC budget

Actual maintenance/operation budget (from APT). This is what the groups are actually spending and not necessarily what is needed.

Manpower:

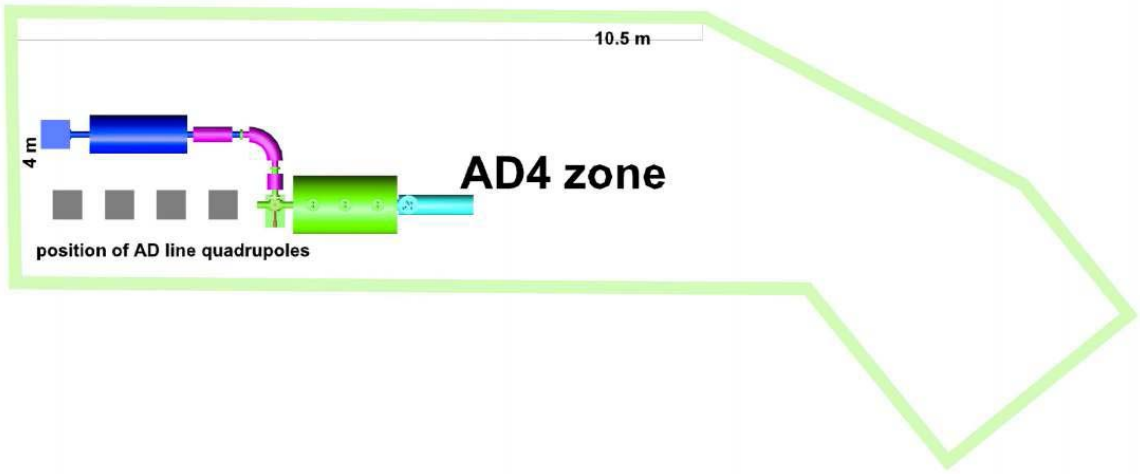
FTEs	2007	2008	2009	2010	2011	Grand Total
AB-ABP	0.30	0.45	0.45	0.45	0.45	**2.10**
AB-ATB	0.45	0.45	0.45	0.45	0.10	**1.90**
AB-BI	1.05	2.55	2.55	2.65	2.65	**11.45**
AB-BT	0.75	0.69	0.85	0.80	0.80	**3.89**
AB-OP	4.09	4.10	4.10	3.81	4.10	**20.20**
AB-PO	0.70	0.70	0.70	0.70	0.70	**3.50**
AB-RF	1.58	1.63	1.60	1.70	1.70	**8.21**
AT-MEL	0.30					**0.30**
AT-VAC	0.80					**0.80**
Grand Total	**10.03**	**10.56**	**10.70**	**10.56**	**10.50**	**52.35**

Material:

	CET extractions of real cost						APT forecast			
kCHF	2003	2004	2005	2006	2007 Likely	2007 Initial	2008	2009	2010	2011
AB-ABP					0	50	50	50	50	50
AB-ATB	8	4		4	10	35	35	35	35	20
AB-BI				8	15	25	25	25	25	25
AB-BT					0	20	26	26	26	26
AB-OP				14	1	15	15	15	15	15
AB-PO	28	54	18	19	50	50	50	50	50	50
AB-RF				15	125	140	165	165	170	170
AT-VAC	156	112	32	45	10	80	80	80	80	80
Grand Total	**192**	**170**	**50**	**105**	**211**	**415**	**446**	**446**	**451**	**436**

6. AEGIS

The proposed AEGIS (Antimatter Experiment: Gravity, Interferometry, Spectroscopy) experiment can be installed in the existing DEM-zone which they would share with the present ACE collaboration. Composed of approximately 60 users, AEGIS will use the 100 MeV/c Pbar beam from AD and perform gravitational studies on Hbars produced in flight. The extension of the existing ACE beamline requires manufacturing and installation of 2 quadrupoles, 1 dipole, 3 combined H/V corrector magnets and 3 BPMs as well as vacuum chambers and equipment.
N.B. Since the existing BPM-system (MWPC) is used to it's maximum capacity and electronic modules are unavailable, this estimate assumes that the MWPC to GEM-detector consolidation mentioned in chapter 2 will be done.
Layout in the existing DEM-zone:
(based on the existing AD layout. If ELENA is to be built, this and the cost estimate would need to be reviewed)



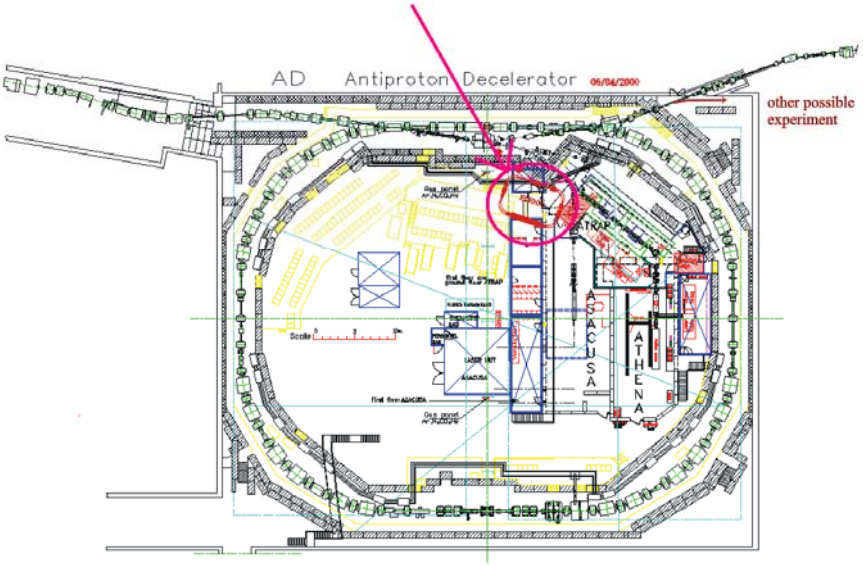
Cost estimate for extension of the existing DEM-line:

	Cost (kSfr)	Manpower (MY)	
Beamline magnets	**75**	**0.33**	
Magnet power converters	**100**		**0.2**
Vacuum equipment	**30**	**0.1**	
Vacuum chambers	**85**	**0.1**	
Diagnostics	**60**	**0.2 (*)**	
Total	**350**	**1.0 (*)**	

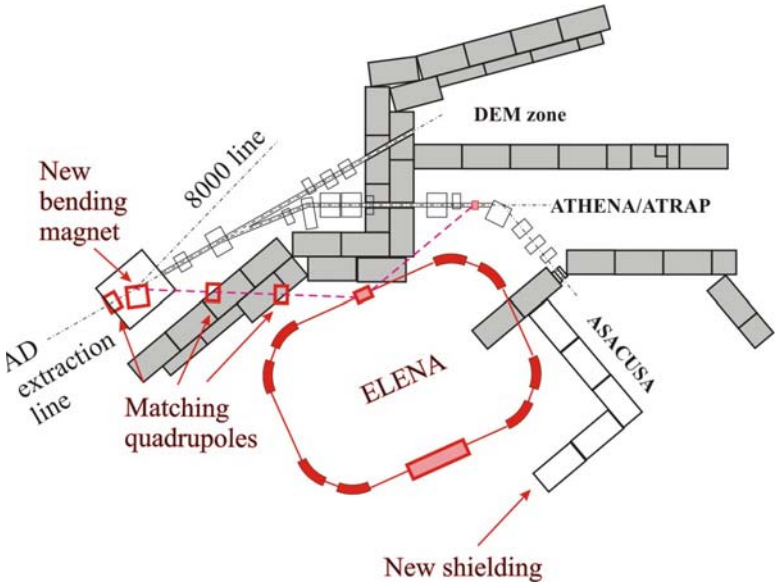
(*) cost of 3 additional channels added to the AD MWPC consolidation program.
If no AD MWPC consolidation is done, one can consider a reduced program (only replacing readout electronics/ctrls) for the MWPCs in use (or find another solution):
Diagnostics (in case of no AD MWPC consolidation) 440 1.5

7. ELENA

In order to improve the trapping efficiency at the main AD experiments, a small additional decelerator & cooling ring has been proposed. Thanks to increased phase-space density and larger number of pbars available at low energy due to use of much thinner degrader foils, an increase in trapping efficiency of up to two orders of magnitude can be expected. ELENA is situated in the existing AD-Hall between the AD ring and the experimental area.
Proposed layout of ELENA In the existing AD hall:



ELENA with transfer lines connecting to AD and existing AD ejection lines:



The estimated time to design, construct and build ELENA is approximately 3.5 years.
A summary of the required resources can be found below. Further details can be found in the ELENA preliminary cost and feasibility study:
http://documents.cern.ch/cgi-bin/setlink?base=preprint&categ=cern&id=ab-2007-079

Item	Material (kCHF)	Manpower FSU (kCHF)	Manpower FTE (MY)
Magnets (ring+inj. line)	**885**	**160**	**3.2**
Power converters	**857**		**1.5**
Injection/ejection septa	**220**		**2.9**
Injection/ejection kickers	**830**		**4.8**
Electron cooler	**1350**		**6.5**
Vacuum	**1175**	**27**	**5.0**
RF + Schottky diagnostics	**303**	**10**	**3.3**
B-trains	**80**		**0.7**
Diagnostics	**620**	**85**	**2.4**
Controls	**682**		**0.7**
H- source	**400**		**0.5**
Experimental area	**2245**		**3.0**
Mech. Design/Drawings			**17.0**
Div.	**290**		**6.5**
Total (MCHF/MY)	**9.937**	**.282**	**58.0**
Grand Total (MCHF/MY)	**10.219**		**58.0**

8. Implications of running AD beyond 2016

The present location of the AD building and target area is not easily compatible with the location of the planned PS2. To continue running the existing AD, a new transfer line looping back through the existing PS-ring tunnel or similar scheme would have to be built. Alternatively, one could either move the existing AD to a new location near PS2 or build a completely new, upgraded antiproton machine.